

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Appl. No.: 10/813,892 Confirmation No.: 5765  
Applicant(s): Comley et al.  
Filed: 03/31/2004  
Art Unit: 1725  
Examiner: Rachel Beveridge  
Title: SUPERPLASTIC FORMING AND DIFFUSION BONDING OF  
FINE GRAIN TITANIUM

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**APPEAL BRIEF UNDER 37 CFR § 41.37**

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" filed June 29, 2007.

1. ***Real Party in Interest.***

The real party in interest in this appeal is The Boeing Company, the assignee of the above-referenced patent application.

2. ***Related Appeals and Interferences.***

There are no related appeals and/or interferences involving this application or its subject matter.

3. ***Status of Claims.***

The present appeal involves Claims 1, 2, 4-12, 16-23, and 36-42, which are presently under a final rejection as set forth in the final Official Action mailed March 30, 2007. The claims stand as last amended in the Amendment filed January 5, 2007. Claims 3, 13-15, 24-35, 43, and 44 have been cancelled. A copy of the claims is included in the Appendix.

4. *Status of Amendments.*

No amendments have been filed since the final Office Action of March 30, 2007, and all previous amendments have been entered.

5. *Summary of Claimed Subject Matter.*

Claim 1 is directed to a method for superplastically forming blanks to produce a first structural member having a predetermined configuration, e.g., the superplastically formed structural member **10** illustrated in Figure 1 of the present application. *See* paragraph [0023]. The method generally includes providing a first and second blank comprising titanium and having a grain size of between 0.8 and 1.2 micron. For example, Figure 2 of the application illustrates a blank **12** supported between opposed dies **22**, **24** of a forming apparatus **20** for forming the structural member of Claim 1. *See* paragraph [0024]. As set forth by Claim 1, each blank is heated to within a diffusion bonding temperature range of each blank, and the first blank is diffusion bonded to the second blank at a diffusion bonding temperature of less than 1450 °F. For example, Figures 3A and 3B illustrate an embodiment in which three sheets **10a**, **10b**, **10c** are provided in an apparatus **20a** with opposed dies **22a**, **24a** that cooperatively define a die cavity **30a** therebetween, and the sheets **10a**, **10b**, **10c** are diffusion bonded (e.g., to form diffusion bonds **54**) that define internal spaces that are inflated, such as in the formation of an expanded honeycomb structure. *See* paragraph [0025]. Claim 1 then recites that the bonded blanks are then heated to within a superplastic forming temperature range of the blanks, and superplastically formed at a forming temperature of less than 1450 °F to produce the structural member having the predetermined configuration. For example, as shown in Figure 3B, a pressurized fluid can be injected through tubes **32a** and between the sheets **10a**, **10b**, **10c** to inflate the pack and thereby superplastically form the sheets **10a**, **10b**, **10c**. Face sheets **10a**, **10c** are superplastically formed against the respective dies **22a**, **24a**, and the middle sheet **10b** is superplastically formed to a corrugated configuration as determined by the diffusion bonds **54** between the middle sheet **10b** and each of the face sheets **10a**, **10c**. *See* paragraph [0025].

Per Claim 1, both the diffusion bonding and superplastic forming are therefore performed at temperatures less than 1450 °F, e.g., diffusion bonding at a temperature between 1400 °F and

1450 °F and/or superplastic forming at a temperature in this range (Claim 10). In fact, as described in the application, the fine grain titanium used in the present invention can be superplastically formed and diffusion bonded at temperatures less than those of conventional superplastic forming and/or diffusion bonding operations. In addition, the superplastic forming can generally be achieved at strain rates that are higher than the strain rates of conventional superplastic forming of titanium members. Thus, relative to conventional superplastic forming of titanium members, the blanks **12** of the present invention generally can be formed at lower temperatures and faster forming rates. *See* paragraph [0031].

For example, the blanks can be superplastically formed at a strain rate of at least about  $6 \times 10^{-4}$  per second (Claim 11) or  $1 \times 10^{-3}$  per second (Claim 12). In this regard, Figure 6 illustrates the true stress and strain of exemplary structural members **10** during superplastic forming operations performed at four different temperatures according to embodiments of the present invention. In particular, Figure 6 is illustrative of flat sheet structural members that were superplastically formed under a tensile force at a strain rate of  $3 \times 10^{-4}$  per second. In separate trials represented by the lines **40**, **42**, **44**, **46**, the structural members **10** were formed at temperatures of 1400 °F (760 °C), 1425 °F (774 °C), 1450 °F (788 °C), and 1500 °F (815 °C), respectively. The true stress represents the force per unit of cross-sectional area of each structural member **10** perpendicular to the primary direction of elongation of the structural member. The true strain represents the elongation per unit length of each structural member **10** in the primary direction of the elongation of the structural member. The true strain is illustrated in Figure 6 along a logarithmic scale in which the true strain values in the graph are equal to the natural log of a ratio of the elongated size of the structural member to the original size of the structural member. That is, a strain value of 1.1 represents a strain of the structural member elongated by about 200% of its original length and a strain value of 1.8 represents a strain of the structural member elongated by about 500% of its original length. *See* paragraph [0031].

In some cases, the reduction in the forming temperature and time required for forming can reduce both the formation of oxides and a layer of alpha case on the structural member **10** during forming. In some cases, a layer of about 0.001 inch or less of alpha case is formed on the surface of the structural member **10** during superplastic forming (Claim 5). For example, Figure 5 illustrates the surface of the structural member **10** after superplastic forming, on which a layer

**14** of about 0.0005 inch (13 micron) of the alpha case oxide was formed. The layer **14** of oxide material formed on the structural member **10** during superplastic forming can be removed using various chemical processes, such as by pickling, as recited in Claim 6. For example, the structural member **10** can be pickled by immersing the structural member **10** in a pickling fluid, such as nitric-hydrofluoric, comprising 40% nitric acid and 4% hydrofluoric acid, or otherwise subjecting the structural member **10** to the pickling fluid, to remove the alpha case and oxide layer **14** formed on the structural member **10** during superplastic forming and/or diffusion bonding. *See* paragraph [0034]-[0035]. As set forth in Claim 8, the pickling step can remove less than about 0.001 inch from each surface of the structural member. *See* paragraph [0035]-[0036]. If opposite surfaces of the structural member **10** are pickled, the thickness of the structural member **10** can be reduced at a rate that is about twice the rate at which material is removed by pickling from each side of the structural member **10**. In some cases, the thickness of the structural member **10** can be reduced by less than about 0.002 inch (Claim 9) in order to substantially remove all of the oxide and alpha case formed on the surfaces during superplastic forming and/or diffusion bonding. Thus, the blank **12** can be superplastically formed to a thickness that is less than about 0.002 inch greater than a desired thickness of the structural member **10**. *See* paragraph [0035].

Such a pickling process can be used to remove the oxide layer **14** from the structural member **10** at a rate that is relatively slow relative to conventional chemical etching processes. For example, the structural member **10** can be dipped in or otherwise subjected to a pickling fluid that removes material from the surface of the structural member **10** at a rate less than about 0.001 inch per 20 minutes, i.e., less than about  $5 \times 10^{-5}$  inch per minute, as recited in Claim 7. In some cases, a reduced rate at which material is removed from the surfaces of the structural member **10** can increase the uniformity of the rate of removal throughout the surfaces of the structural member **10**. *See* paragraph [0036].

Each of independent Claims 16 and 36 is also directed to a method for superplastically forming a blank to produce a structural member having a predetermined configuration, and these methods include features of the previously described claims. In particular, Claim 16 includes the features of Claims 1 and 6, and Claim 36 includes the features of Claims 1 and 11. The

remaining dependent Claims 17-23 and 37-42 include features generally corresponding to dependent Claims 2, 4, and 5-12.

6. ***Grounds of Rejection to be Reviewed on Appeal.***

The following grounds of rejection are appealed:

(1) Claims 1, 2, 4, and 10-12 are rejected under § 103(a) as being unpatentable over U.S. Patent No. 4,882,823 (“Weisert, et al.”) in view of U.S. Patent No. 3,713,207 (“Ruckle ’207”), U.S. Patent No. 4,982,893 (“Ruckle ’893”), and WO 95/13406 to (“Movchan, et al.”).

(2) Claims 5-9 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Weisert, et al. in view of Ruckle ’207, Ruckle ’893, and Movchan, et al. in further view of U.S. Patent No. 5,118,026 (“Stacher”).

(3) Claims 16-23 and 36-42 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Weisert, et al. in view of Ruckle ’207, Ruckle ’893, Movchan, et al., and Stacher.

7. ***Argument.***

The rejections are respectfully traversed on the following grounds.

**A. Claims 1, 2, 4, and 10-12 are not obvious over Weisert, et al. in view of Ruckle ’207, Ruckle ’893, and Movchan, et al.**

Claims 1, 2, 4, and 10-12 are rejected under § 103(a) solely as being unpatentable over Weisert, et al. in view of Ruckle ’207, Ruckle ’893, and Movchan, et al. As set forth below, Appellant submits that Weisert, et al. in view of Ruckle ’207, Ruckle ’893, and Movchan, et al. cannot be fairly combined as asserted in the Office Action and, further, even if combined, the references do not disclose each of the features of these claims.

**1. It would not have been obvious to modify Weisert, et al. in light of Ruckle ’207, Ruckle ’893, and Movchan, et al. to achieve the grain size of Claim 1**

As described above, Claim 1 is directed to a method for superplastically forming blanks to produce a first structural member having a predetermined configuration. The method includes providing first and second blanks that comprise titanium and have a grain size of between 0.8

and 1.2 micron, heating the blanks, diffusion bonding the blanks at less than 1450 °F, and superplastically forming the bonded blanks at less than 1450 °F.

The Office Action acknowledges that Weisert, et al. fails to disclose a number of features of Claim 1, namely, (1) the grain size of the materials of the blanks, (2) a diffusion bonding temperature less than 1450 °F, and (3) a superplastic forming temperature less than 1450 °F. *See* final Office Action, page 3. However, the Office Action asserts that it would have been obvious to modify Weisert, et al. in light of Ruckle '207, Ruckle '893, and Movchan, et al. to include these features.

In particular, regarding the recited grain size of Claim 1, the Office Action states that "Ruckle '207 generally teaches a superplastic titanium alloy with a grain size of about 1 micron (Ruckle '207, col. 4, lines 46-48 and col. 2, lines 63-67 through col. 3, lines 1-3)" (final Office Action, page 3) and that it would have been obvious "to modify the invention of Weisert to include the grain size of typical titanium alloy of Ruckle '207 in order to provide alloys with the ability to form homogeneous diffusion bonded joints at reduced pressures (Ruckle '207, col. 3, lines 32-34)" (final Office Action, page 4).

Appellant respectfully disagrees. Weisert, et al. is directed to a forming method in which sheets are diffusion bonded and superplastic formed in subsequent operations that are carried out under conventional conditions. *See* col. 4, lines 10-30. Ruckle '207, on the other hand, discloses a process in which "surfaces to be diffusion bonded are positioned in abutment with a sheet of material in a condition of superplasticity sandwiched therebetween." Col. 3, lines 26-29. In other words, a superplastic material is provided between the two surfaces to be joined so that the superplastic material fills voids between the surfaces of the two joined members. *See* col. 3, lines 32-47. Ruckle '207 does not teach or suggest that the two members themselves are formed of a superplastic material and, in particular, a superplastic material having any particular grain size. Nor does either Weisert, et al. or Ruckle '207 provide any motivation for forming the sheets of Weisert, et al. of the material used by Ruckle '207 to fill voids between joined members. Accordingly, even in fair consideration of Ruckle '207, it would not have been obvious to form the two contoured sheets of Weisert, et al. of such a material as recited in Claim 1.

Accordingly, Appellant submits that Claim 1 is allowable over the cited references, as are each of the dependent Claims 2 and 4-12.

**2. Even in combination, the cited references do not teach each of the features of Claim 1**

Regarding the diffusion bonding temperature of Claim 1, the final Office Action acknowledges that Weisert, et al. fails to disclose diffusion bonding at a temperature of less than 1450 °F; however, the Office Action asserts that “Ruckle ‘893 discloses diffusion bonding multiple titanium alloy blanks at a temperature of less than 1450°F (Ruckle ‘893, col. 2, lines 19-23)” (final Office Action, page 3) and that it would have been obvious “further to modify the combined invention of Weisert and Ruckle ‘207 to include the diffusion bonding temperature of Ruckle ‘893 in order to increase the rate of diffusion so that voids can be eliminated and bonding achieved without excessive pressure or excessive bonding time (Ruckle ‘893, col. 2, lines 19-23)” (final Office Action, page 4).

Appellant again disagrees on the basis that, even if Weisert, et al. could fairly be modified in light of Ruckle ‘207, it would not have been obvious to modify Weisert, et al. further to include the use of the recited diffusion bonding temperature. Indeed, Ruckle ‘893 does not even teach such a bonding temperature. The portion of Ruckle ‘893 that is cited in the Office Action in this regard (col. 2, lines 19-23), merely states that “diffusion bonding temperatures are usually selected which range from about the beta transus temperature (about 995° C.) to well below the beta transus temperature (about 870° C.)” In other words, Ruckle ‘893 merely discloses that the temperature usually selected for diffusion bonding can be as low as 870° C, or 1598° F. Ruckle ‘893 does not teach diffusion bonding at a temperature of less than 1450° F as set forth in Claim 1. This difference of nearly 150° F is significant, especially in light of the description of the present application, which specifically describes the use of diffusion bonding temperatures of less than 1450° F as an alternative to conventional diffusion bonding operations occurring at 1650° F.

Appellant previously noted this deficiency of the cited references and, in response to Appellant’s previous comments, the final Office Action now acknowledges that “the temperature disclosed by Ruckle ‘893 is not exactly that limited by the claim.” Final Office Action, page 12.

Nevertheless, the final Office Action maintains the rejection and further states that “the rejection of claim 1 is over more than one reference and not only in view of Ruckle ‘893.” Id. However, the Office Action does not point to any reference that discloses the claimed feature. Instead, the Office Action states as follows:

Weisert discloses diffusion bonding titanium alloys . . . usually from about 150-600 psi (Weisert, col. 4, lines 22-26). This disclosure is equivalent to applicant’s disclosure for diffusion bonding titanium blanks from pressures ranging from about 250-400 psi at temperatures of less than 1500°F (applicant’s specification page 7). Ruckle ‘893 further discloses titanium alloys (without a stopoff material) with the temperature limits as cited in the rejection.

Office Action, page 12 (emphasis added).

Thus, even in the response to Appellant’s prior arguments, the final Office Action again relies on its comments regarding the temperatures disclosed by Ruckle ‘893. However, as noted above, Ruckle ‘893 does not teach the temperatures as asserted in the Office Action. Again, Appellant points to the Office Action’s statement regarding the temperature limits of Ruckle ‘893:

Ruckle ‘893 discloses diffusion bonding multiple titanium alloy at a temperature of less than 1450°F (Ruckle ‘893, col. 2, lines 19-23).

Final Office Action, page 3.

This statement is not supported by Ruckle, et al., and the Office Action even acknowledges this deficiency, but the rejection and the remarks made in the Office Action continue to rely on this statement.

No reference has been identified to disclose this feature of Claim 1, and Appellant accordingly submits that Claim 1 is allowable for this additional reason, as are each of the dependent Claims 2 and 4-12.

**3. It would not have been obvious to modify Weisert, et al. in light Movchan, et al. to achieve the invention of Claim 1**

Regarding the recitation of Claim 1 concerning the superplastic forming temperature, the final Office Action acknowledges that Weisert, et al. does not teach superplastically forming at a temperature less than 1450° F; however, the Office Action , asserts that this deficiency of Weisert, et al. is cured by Movchan, et al. In particular, the Office Action states that it would



have been obvious “to further modify the combined invention of Weisert, Ruckle ‘207, Ruckle ‘893 to include the superplastic formation temperature and strain rates of Movchan in order to superplastically form titanium blanks at temperature where oxidation is not a problem even in ambient atmospheres (Movchan et al., p. 3, lines 24-26).” Office Action, page 4.

Appellant again respectfully disagrees. Movchan, et al. discloses the use of a material that is vapor deposited on a substrate under certain conditions to have a very particular structure, i.e., grains having a short diameter in a plane parallel to the substrate and a long dimension in a plane perpendicular to the substrate, with a specified range of ratios therebetween. According to Movchan, et al., the “deposition process produces grains which meet the requirements for superplasticity in two dimensions, but not in a third dimension.” See pages 6-7. Given the stated importance of the structure and the sensitivity to variations in the process, it would not have been obvious to modify the superplastic forming operation of the contrary materials of Weisert, et al. to conform to the process discussed by Movchan, et al.

Further, Appellant has previously explained that, even if the materials of Weisert, et al. could have been modified to conform to the specifications discussed by Movchan, et al., the materials would not have the refined grain structure of Claim 1, but would instead be characterized by grains having a long dimension such that the requirements for superplasticity would not be met in the third dimension. The final Office Action responds as follows:

The applicant also alleges that if the materials of Weisert could have been modified to conform to the specifications discussed by Movchan, the materials would not have the refined grain structure of Claim 1, but would instead be characterized by grains having a long dimension such that the requirements for superplasticity would not be met in the third dimension (page 9). The examiner notes the applicant’s argument; however, applicant has provided no evidence or support for this assumption.

Final Office Action, page 14 (emphasis added).

Appellant respectfully submits that no additional evidence or support is required because the above comments are not based on assumption. Indeed, Movchan specifically describes the grains as having a short diameter in a plane parallel to the substrate and a long dimension in a plane perpendicular to the substrate, and further states that the grains produced by the deposition process “meet the requirements for superplasticity in two dimensions, but not in a third dimension.” See pages 6-7.

Thus, even if the references could be fairly combined, the result would not provide the specified grain size of Claim 1, and a prima facie case of obvious has not been made in this regard. Accordingly, Appellant submits that Claim 1 is allowable for this additional reason, as are each of the dependent Claims 2 and 4-12.

**4. The cited references do not disclose the elements of Dependent Claim 10**

Claim 10 recites “superplastically forming the structural member at a temperature between 1400 °F and 1450 °F.” Appellant has previously asserted that no reference disclosing this feature has been shown. In response, the final Office Action states as follows:

The applicant argues that the office action has not acknowledged any references as teaching the features of claim 10 for “superplastically forming the structural member at a temperature between 1400°F and 1450°F” (page 9). The examiner disagrees and reminds the applicant that both Weisert and Movchan disclose superplastically forming titanium blanks within this temperature range (see pages 3-4 of the office action mailed on November 16, 2006).

Final Office Action, page 15.

Neither Weisert nor Movchan disclose the feature of claim 10. Nor does the cited portion of the earlier Office Action point to any such teaching in Weisert or Movchan. To the contrary, each of the previous Office Action and the final Office Action specifically acknowledges that Weisert, Ruckle ‘207, and Ruckle ‘893 do not teach this feature and that “Movchan discloses superplastic deformation of titanium alloy blanks at temperatures between 650-760°C (1202-1400°F).” Office Action of November 16, 2006, pages 3-4; Final Office Action, page 3.

Movchan states that “[a]t elevated temperatures, above about 650°C to 760°C, and in the presence of oxygen, titanium is subject to rapid oxidation and rapid absorption of oxygen atoms into the lattice. Oxygen tends to embrittle titanium and is known to be a stabilizer of the alpha phase. Consequently, alpha plus beta titanium alloys, which are the most widely used class of titanium alloys, are prone to the formation of a deleterious surface layer known as an alpha case when exposed to oxygen in temperatures in excess of about 650°C.” Pages 2-3. According to the portion of Movchan that is cited in the Office Action, it is “an object of the present invention to describe a titanium material, and a method for producing such material, which can be superplastically formed at conditions below about 760°C and preferably below 650°C and which

can therefore be superplastically formed at temperatures where oxidation is not a problem even in ambient atmospheres.” Page 3.

Thus, Movchan does not disclose the feature of Claim 10. Further, since Movchan is specifically directed to the use of temperatures below about 760°C and preferably below 650°C, it would not have been obvious to use a higher temperature in light of Movchan. More specifically, it would not have been obvious to modify the combined teachings of Weisert, Ruckle ‘207, and Ruckle ‘893 in light of Movchan to include superplastic forming at a temperature between 1400 °F and 1450 °F. Indeed, Movchan specifically teaches away from such a modification, noting that alpha plus beta titanium alloys are prone to the formation of the deleterious surface layer of alpha case when exposed to oxygen in temperatures in excess of about 650°C (1202°F).

Accordingly, Appellant submits that Claim 10 is allowable for this additional reason.

#### **5. The cited references do not disclose the elements of Dependent Claims 11 and 12**

Claim 11 recites “superplastically forming the blanks at a strain rate of at least about  $6 \times 10^{-4}$  per second” and Claim 12 recites “a strain rate of at least about  $1 \times 10^{-3}$  per second.” The final Office Action states that “the properties and method of invention are so similar with that of the applicant’s claimed invention it is necessarily present to arrive at the specified strain rates of claims 11 and 12.” Final Office Action, page 3.

Appellant disagrees. The specified strain rates are neither disclosed by, nor inherent in, the process of Weisert, et al. Moreover, given the differences in the material properties of conventional materials and the materials described by the present invention, it is not even clear that the process of Weisert, et al. could be performed at the specified strain rates. Further, with regard to the strain rates discussed in Movchan, et al., Appellant again notes the dissimilarities of the material disclosed by Movchan, et al. and the materials of the other cited references. In light of these differences, it would not have been obvious to apply the strain rates disclosed by Movchan, et al. to the different materials disclosed by Weisert, et al.

In addition, even if the process of Weisert, et al. could be performed at the recited strain rates, the references do not provide any motivation for modifying the strain rates of Weisert, et al. In this regard, the Office Action states that the modification would have been obvious “to

superplastically form titanium blanks at temperatures where oxidation is not a problem even in ambient atmospheres” but does not indicate how the modification to the strain rate effects this purpose. Further, Weisert, et al. teaches away from such a modification by pointing to the avoidance of excessive strain rates as preventing rupturing of the structure. See col. 5, lines 39-43. Indeed, the application of strain rates discussed by Movchan to the materials and processes of Weisert, et al. amounts to an impermissible selection and combination of features from the cited references guided by hindsight, i.e., in light of the teachings of the present invention.

Accordingly, Appellant submits that Claims 1 and 12 are allowable for this additional reason.

**B. Claims 5-9 are not obvious over Weisert, et al. in view of Ruckle '207, Ruckle '893, Movchan, et al., and Stacher**

**1. The cited references do not disclose the elements of Dependent Claim 5**

Dependent Claim 5 stands rejected as being obvious over Weisert, et al. in view of Ruckle '207, Ruckle '893, and Movchan, et al. in further view of Stacher. As set forth above, Weisert, et al., Ruckle '207, Ruckle '893, and Movchan, et al. do not disclose each of the features of independent Claim 1. Accordingly, since Stacher also fails to cure the above-described deficiencies of the other cited references, Appellant submits that Claim 5 is allowable for the same reasons.

**2. The cited references do not disclose the elements of Dependent Claim 6**

Claim 6 depends from Claim 1 and further recites “pickling the structural member to remove alpha case oxide formed thereon during said superplastically forming step.” Thus, the claim requires that the pickling is performed after the superplastically forming step, i.e., to remove alpha case oxide formed during the superplastic forming. The final Office Action, in this regard, notes that Weisert, et al., even when combined with Ruckle '207, Ruckle '893, and Movchan, et al., lacks disclosure of such a pickling step. However, the Office Action asserts that “Stacher further teaches that the surfaces require preparatory cleaning (i.e. pickling) (Stacher,

col. 2, lines 45-47) and states that further application of pressure breaks up the surface oxides to present clean surfaces for bonding (Stacher, col. 2, lines 53-55)." Final Office Action, pages 4-5.

The Office Action does not even assert that Stacher discloses pickling a structural member to remove alpha case oxide that is formed thereon during a superplastically forming step, as recited in Claim 6.

The final Office Action asserts that the preparatory cleaning of Stacher corresponds to the recited pickling operation and, the Office Action states that it would have been obvious "to modify the combined invention of Weisert[,] Ruckle '207, Ruckle '893, and Movchan to include the pickling step of Stacher in order to significantly lower the cost, difficulty, and time involved in diffusion bonding and superplastic forming titanium alloy structures (Stacher, col. 3, lines 30-36)." Final Office Action, page 5. However, as Appellant has previously explained, Claim 6 requires pickling after the superplastic forming step to remove alpha case oxide formed during superplastically forming. The references do not teach or suggest this feature of Claim 6, and a person of ordinary skill in the art would not have been motivated to perform the claimed pickling step after superplastic forming in order to affect a diffusion bonding operation that occurs prior thereto. Indeed, it is unclear how pickling the formed part of Weisert, et al. after superplastic forming (as recited in Claim 6) would address the supposed motivation of Stacher for lowering the cost, difficulty, and time involved in the previously performed diffusion bonding and superplastic forming operations.

In response to Appellant's prior arguments, the final Office Action further states that Movchan discloses the formation of oxidation at elevated temperatures during superplastic forming and that it would have been obvious "to utilize such a cleaning process (pickling) to remove oxides that formed during the superplastic forming steps of the prior art for the same or similar reasons that Stacher utilizes pickling to clean the surface of Ti alloys before diffusion bonding (because the unprotected, oxidized, Ti alloy become[s] embrittled and its integrity is destroyed; Stacher, col. 2, lines 35-37)." Final Office Action, page 18.

Appellant disagrees on the basis that Stacher provides no motivation for performing the preparatory cleaning after superplastic forming. Indeed, the cited portion of Stacher refers to the necessity for "carrying out the process of superplastic forming" by heating and forming "in a controlled environment." Col. 2, lines 30-38. This is unrelated to the preparatory cleaning that

Stacher uses before diffusion bonding. Moreover, Stacher's concern that the titanium aluminide can become embrittled and its integrity can be destroyed, is addressed by "carrying out the process of superplastic forming . . . in a controlled environment to ensure cleanliness of the titanium" not by performing a preparatory cleaning after forming.

Accordingly, since the references do not provide any suggestion for pickling after superplastically forming, Appellant submits that Claim 6 is allowable for this additional reason, as are each of Claims 7-9.

### **3. The cited references do not disclose the elements of Dependent Claims 7**

Claim 7 depends from Claim 6 and should therefore be allowable for the same reasons discussed above in connection with Claims 1 and 6. In addition, Claim 7 provides further features that are not taught or suggested by the cited references. Further, the Office Action does not refer to any reference as teaching these features but simply asserts that the claims are obvious. In particular, Claim 7 recites that the pickling step "comprises subjecting the structural member to a pickling fluid and thereby removing material from surfaces of the structural member at a rate less than about  $5 \times 10^{-5}$  inch per minute." The Office Action does not refer to the use of a pickling fluid in the cited references and does not refer to any such rate of material removal in the cited references. Instead, e.g. the Office Action states that "with the combined invention of Weisert, Ruckle '207, Ruckle '893, Movchan, and Stacher it is obvious to arrive at the claimed pickling rate." Final Office Action, page 5.

In response to Appellant's prior arguments in this regard, the final Office Action further states that "it is *prima facie* obvious to arrive at the claimed ranges for a pickling rate on the same materials under the same/similar conditions at the other prior art cited of record and as disclosed by the applicant. Put another way, Stacher teach pickling titanium alloys to remove oxide from the surface to be an art recognized result effective variable depending on the type of material to be used." Final Office Action, pages 18-19.

Given that Stacher only refers to preparatory cleaning and under different conditions than the present invention, Stacher does not provide any teaching for the claimed pickling rate of Claim 7. Moreover, contrary to the above assertion from the Office Action, Stacher does not

teach that the preparatory cleaning step can be used to achieve an “art recognized result effective variable depending on the type of material to be used.”

Accordingly, Appellant submits that Claim 7 is allowable for this additional reason.

**4. The cited references do not disclose the elements of Dependent Claim 8**

Claim 8 depends from Claim 6 and should therefore be allowable for the same reasons discussed above in connection with Claims 1 and 6. In addition, Claim 8 provides further features that are not taught or suggested by the cited references. In particular, Claim 8 recites the removal of “less than about 0.001 inch from each surface of the structural member.” The Office Action does not refer to any such teaching in the prior art but simply states that “with the combined invention of Weisert, Ruckle ‘207, Ruckle ‘893, Movchan, and Stacher it is obvious to arrive at the claimed amount of oxide to be removed from the surfaces.” Final Office Action, page 6. According to the Office Action, it would have been obvious “to modify the combined invention of Weisert, Ruckle ‘207, Ruckle ‘893, and Movchan to include the picking step of Stacher in order to remove an accurate amount of oxide to obtain the maximum obtainable joint strength (Stacher, col. 2, lines 50-53).” Final Office Action, page 6.

However, the cited portion of Stacher does not support this alleged motivation. The cited portion of Stacher states that adequate pressure must be provided for diffusion bonding in order to obtain the maximum joint strength. The cited portion does not refer to the thickness of material to be removed from each surface or provide any motivation for removing a particular minimum thickness.

Accordingly, Appellant submits that Claim 8 is allowable for this additional reason.

**C. Claims 16-23 and 36-42 are not obvious over Weisert, et al. in view of Ruckle ‘207, Ruckle ‘893, Movchan, et al., and Stacher**

**1. The cited references do not disclose the elements of independent Claim 16 and dependent Claims 17-23**

Independent Claim 16 and dependent Claims 17-23 stand rejected under § 103(a) as being unpatentable over Weisert, et al. in view of Ruckle ‘207, Ruckle ‘893, Movchan, et al., and

Stacher. Claim 16 includes the above-noted features of Claims 1 and 6. Therefore, Claim 16 should be allowable over the cited references for each of the reasons discussed above in connection with Claims 1 and 6.

Dependent Claims 17-23 should also be allowable for the same reasons. Further, since these dependent claims include other features discussed above in connection with the dependent Claims 2 and 4-12, dependent Claims 17-23 should be allowable for these additional reasons.

**2. The cited references do not disclose the elements of independent Claim 36 and dependent Claims 37-42**

Independent Claim 36 and dependent Claims 37-42 stand rejected under § 103(a) as being unpatentable over Weisert, et al. in view of Ruckle '207, Ruckle '893, Movchan, et al., and Stacher. Claim 36 includes the above-noted features of Claims 1 and 11. Therefore, Claim 36 should be allowable over the cited references for each of the reasons discussed above in connection with Claims 1 and 11.

Dependent Claims 37-42 should also be allowable for the same reasons. Further, since these dependent claims include other features discussed above in connection with the dependent Claims 2 and 4-12, dependent Claims 37-42 should be allowable for these additional reasons.

8. ***Claims Appendix.***

An appendix containing a copy of the claims involved in the appeal.

9. ***Evidence Appendix.***

An appendix containing copies of any evidence submitted.

10. ***Related Proceedings Appendix.***



### **CONCLUSION**

For the above reasons, it is submitted that the rejections of Claims 1, 2, 4-12, 16-23, and 36-42 are erroneous and reversal of the rejections is respectfully requested.

Respectfully submitted,



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**8. Appendix – Listing of Pending Claims**

The claims subject to this appeal are as follows:

1. (Previously Presented) A method for superplastically forming blanks to produce a first structural member having a predetermined configuration, the method comprising:  
providing a first and second blank comprising titanium and having a grain size of between 0.8 and 1.2 micron;  
heating each blank to within a diffusion bonding temperature range of each blank;  
diffusion bonding the first blank to the second blank at a diffusion bonding temperature of less than 1450 °F;  
heating the bonded blanks to within a superplastic forming temperature range of the blanks; and  
superplastically forming the bonded blanks at a forming temperature of less than 1450 °F to produce the structural member having the predetermined configuration.
2. (Previously Presented) A method according to Claim 1 wherein said providing step comprises providing the blanks formed of Ti-6Al-4V.
3. (Cancelled)
4. (Previously Presented) A method according to Claim 1 wherein said providing step comprises providing the blanks having a grain size of about 1 micron.
5. (Original) A method according to Claim 1 wherein said superplastically forming step comprises forming less than about 0.001 inch alpha case oxide layer on each surface of the structural member.
6. (Original) A method according to Claim 1 further comprising pickling the structural member to remove alpha case oxide formed thereon during said superplastically forming step.

7. (Original) A method according to Claim 6 wherein said pickling step comprises subjecting the structural member to a pickling fluid and thereby removing material from surfaces of the structural member at a rate less than about  $5 \times 10^{-5}$  inch per minute.

8. (Original) A method according to Claim 6 wherein said pickling step comprises removing less than about 0.001 inch from each surface of the structural member.

9. (Previously Presented) A method according to Claim 6 wherein said superplastically forming step comprises forming the blanks to a thickness less than about 0.002 inch greater than a desired thickness of the structural member.

10. (Previously Presented) A method according to Claim 1 wherein said superplastically forming step comprises superplastically forming the structural member at a temperature between 1400 °F and 1450 °F.

11. (Previously Presented) A method according to Claim 1 wherein said superplastically forming step comprises superplastically forming the blanks at a strain rate of at least about  $6 \times 10^{-4}$  per second.

12. (Previously Presented) A method according to Claim 1 wherein said superplastically forming step comprises superplastically forming the blanks at a strain rate of at least about  $1 \times 10^{-3}$  per second.

Claims 13 – 15 (Cancelled)

16. (Previously Presented) A method for superplastically forming blanks to produce a structural member having a predetermined configuration, the method comprising:

providing first and second blanks formed of Ti-6Al-4V and having a grain size of between 0.8 and 1.2 micron;

heating each blank to within a diffusion bonding temperature range of each blank;

diffusion bonding the first blank to the second blank at a diffusion bonding temperature of less than 1450 °F;

heating the bonded blanks to within a superplastic forming temperature range of the blanks;

superplastically forming the bonded blanks at a forming temperature of less than 1450 °F to produce the structural member having the predetermined configuration, thereby forming a layer of alpha case oxide of less than about 0.001 inch thickness on each surface of the structural member; and

pickling the structural member to remove the alpha case oxide layer.

17. (Previously Presented) A method according to Claim 16 wherein said providing step comprises providing the blanks having a grain size of about 1 micron.

18. (Original) A method according to Claim 16 wherein said pickling step comprises subjecting the structural member to a pickling fluid and thereby removing material from surfaces of the structural member at a rate less than about  $5 \times 10^{-5}$  inch per minute.

19. (Original) A method according to Claim 16 wherein said pickling step comprises removing less than about 0.001 inch from each surface of the structural member.

20. (Previously Presented) A method according to Claim 16 wherein said superplastically forming step comprises forming the blanks to a thickness less than about 0.002 inch greater than a desired thickness of the structural member.

21. (Original) A method according to Claim 16 wherein said superplastically forming step comprises superplastically forming the structural member at a temperature of about 1425 °F.

22. (Previously Presented) A method according to Claim 16 wherein said superplastically forming step comprises superplastically forming the blanks at a strain rate of at least about  $6 \times 10^{-4}$  per second.

23. (Previously Presented) A method according to Claim 16 wherein said superplastically forming step comprises superplastically forming the blanks at a strain rate of at least about  $1 \times 10^{-3}$  per second.

36. (Previously Presented) A method for superplastically forming blanks to produce a structural member having a predetermined configuration, the method comprising:

providing first and second blanks formed of Ti-6Al-4V and having a grain size of between about 0.8 and 1.2 micron;

heating each blank to within a diffusion bonding temperature range of each blank;

diffusion bonding the first blank to the second blank at a diffusion bonding temperature of less than 1450 °F;

heating the bonded blanks to within a superplastic forming temperature range of the blanks; and

superplastically forming the bonded blanks at a forming temperature of less than 1450 °F and at a strain rate of at least about  $6 \times 10^{-4}$  per second to produce the structural member having the predetermined configuration.

37. (Previously Presented) A method according to Claim 36 wherein said providing step comprises providing the blanks having a grain size of about 1 micron.

38. (Previously Presented) A method according to Claim 36, further comprising subjecting the structural member to a pickling fluid and thereby removing material from surfaces of the structural member at a rate less than about  $5 \times 10^{-5}$  inch per minute.

39. (Previously Presented) A method according to Claim 38 wherein said subjecting step comprises removing less than about 0.001 inch from each surface of the structural member.

40. (Previously Presented) A method according to Claim 36 wherein said superplastically forming step comprises forming the blanks to a thickness less than about 0.002 inch greater than a desired thickness of the structural member.

41. (Previously Presented) A method according to Claim 36 wherein said superplastically forming step comprises superplastically forming the structural member at a temperature of about 1425 °F.

In re: Comley, et al.

Appl. No.: 10/813,892

Filing Date: 03/31/2004

Page 22

42. (Previously presented) A method according to Claim 36 wherein said superplastically forming step comprises superplastically forming the blanks at a strain rate of at least about  $1 \times 10^{-3}$  per second.

Claims 43 – 44 (Cancelled)

**9. Evidence Appendix**

None.

**10. Related Proceedings Appendix**

None.